

## *CLAIMS*

(1) A wireless packet communication method of transmitting data packets by use of radio channels which are determined to be idle by carrier sense, between more than three STAs in which a plurality of radio channels are available, characterized by comprising:

5 individually managing, for each receiver terminal, a plurality of types of available transmission rates to be used for transmission of said data packets;

when there are a plurality of data packets to be transmitted onto a transmission buffer and when it is possible to transmit said plurality of data packets simultaneously, referring to packet sizes representative of data amounts of the respective data packets and to transmission rates of the respective data packets associated with receiver terminals, checking packet time lengths of the respective data packets, and selecting said plurality of data packets whose packet time lengths are approximately equal to each other regardless of their receiver terminals, the packet times lengths being transmission times defined by the packet sizes and transmission rates; and

15 simultaneously commencing the transmissions of said plurality of selected data packets by use of a plurality of radio channels.

(2) A wireless packet communication method of transmitting data packets by MIMO by use of radio channels which are determined to be idle by carrier sense, between more than three STAs which can perform the MIMO on a plurality of signals for one radio channel, characterized by:

20 individually managing, for each receiver terminal, a plurality of types of available transmission rates to be used for transmission of said data packets;

when there are a plurality of data packets to be transmitted onto a transmission buffer and when it is possible to transmit said plurality of data packets simultaneously, referring to packet sizes representative of data amounts of the respective data packets and to

transmission rates of the respective data packets associated with receiver terminals, checking packet time lengths of the respective data packets, and selecting said plurality of data packets whose packet time lengths are approximately equal to each other regardless of their receiver terminals, the packet times lengths being transmission times defined by the packet sizes and  
5 transmission rates;

determining, from the packet time lengths of said data packets and of acknowledgment packets to be calculated from the transmission rates of the data packets associated with destinations, time when the receiver terminals of the data packets transmit acknowledgment packets, and storing, in the respective data packets, information on  
10 acknowledgment packet transmission time and information on a transmission deferral duration (NAV) which is a period of time taken for completion of transmissions of acknowledgment packets to all of data packets simultaneously transmitted, the acknowledgment packet transmission time being time when the receiver terminals of the respective data packets are allowed to transmit acknowledgment packets; and

15 simultaneously commencing the transmissions of said plurality selected data packets by the MIMO.

(3) The wireless packet communication method according to claim 1 or 2, characterized by further comprising

switching over to transmissions at lower transmission rates when said plurality of  
20 data packets whose packet time lengths are approximately equal to each other are selected in association with transmission rates lower than a current transmission rate.

(4) The wireless packet communication method according to claim 1 or 2, characterized by further comprising

when a first mode and a second mode can be selected, comparing transmission  
25 efficiency under said first mode to transmission efficiency under said second mode, and

selecting, according to a result of the comparison, a plurality of data packets whose packet time lengths are approximately equal to each other, the first mode in which a plurality of data packets whose packet time lengths are equal to each other are generated by dividing a unit of data on a transmission buffer, the second mode in which a plurality of data packets whose packet time lengths are substantially equal to each other are generated by adding a dummy signal to at least one of the plurality of data packets whose packet time lengths are different from each other.

(5) The wireless packet communication method according to claim 1, characterized in that:

an STA receiving said plurality of data packets including data packets addressed to an own station generates acknowledgment packets to the data packets addressed to the own station and compares receive rates of all data packets received simultaneously to each other; and

the STA detects a maximum mandatory rate as a lowest receive rate and transmits the acknowledgment packets at the lowest receive rate, the maximum mandatory rate not exceeding a minimum value of the receive rates of all the data packets.

(6) The wireless packet communication method according to claim 1, characterized in that:

an STA receiving said plurality of data packets including data packets addressed to an own station generates acknowledgment packets to the data packets addressed to the own station and compares receive rates of all data packets received simultaneously to each other;

when said receive rates of all the data packets are not equal to each other, the STA detects as a lowest receive rate a maximum mandatory rate not exceeding a minimum value of all the receive rates, and detects as a local receive rate a maximum mandatory rate not exceeding the receive rate of the data packet addressed to the own station;

when said local receive rate is higher than said lowest receive rate, the STA adds, to said acknowledgment packets, a dummy bit corresponding to a difference between a first packet time length of an acknowledgment packet to be calculated from said lowest receive rate and a second packet time length of an acknowledgment packet to be calculated from said local receive rate to transmit them at said local receive rate; and

when said local receive rate and said lowest receive rate are equal to each other, the STA transmits said acknowledgment packets at said lowest receive rate.

(7) The wireless packet communication method according to claim 1, characterized in that:

an STA receiving said plurality of data packets including data packets addressed to an own station generates acknowledgment packets to the data packets addressed to the own station and compares receive rates of all data packets received simultaneously to each other;

when said receive rates of all the data packets are not equal to each other, the STA detects as a lowest receive rate a maximum mandatory rate not exceeding a minimum value of all the receive rates, and detects as a local receive rate a maximum mandatory rate not exceeding the receive rate of the data packet addressed to the own station;

when said local receive rate is higher than said lowest receive rate, the STA sets a transmission deferral duration (NAV) in said acknowledgment packets according to a packet time length of an acknowledgment packet to be calculated from said lowest receive rate and transmits them at said local receive rate; and

when said local receive rate and said lowest receive rate are equal to each other, the STA transmits said acknowledgment packets at said lowest receive rate.

(8) The wireless packet communication method according to claim 2, characterized in that:

an STA receiving said plurality of data packets including data packets addressed to

an own station generates acknowledgment packets to the data packets addressed to the own station and detects acknowledgment-packet transmission times which are held in the data packets addressed to the own station; and

the STA transmits said acknowledgment packets at the timing of the acknowledgment-packet transmission times at the maximum mandatory rate that does not exceed the receive rate of the data packet addressed to the own station.

(9) The wireless packet communication method according to claim 2, characterized by further comprising

detecting a number ( $N_{ch}$ ) of idle radio channels and a number ( $N_p$ ) of said data packets whose packet time lengths are approximately equal to each other, and simultaneously transmitting  $N_p$  data packets by use of  $N_p$  idle channels without using the MIMO when  $N_{ch}$  is more than  $N_p$  ( $N_{ch} \geq N_p$ ), and simultaneously transmitting a plurality of data packets using the MIMO when  $N_{ch}$  is less than  $N_p$  ( $N_{ch} < N_p$ ).

(10) A wireless packet communication apparatus that transmits data packets by use of radio channels which are determined to be idle by carrier sense, between more than three STAs in which a plurality of radio channels are available, the wireless packet communication apparatus characterized by comprising:

a unit that individually manages, for each receiver terminal, a plurality of types of available transmission rates to be used for transmissions of said data packets;

when there are a plurality of data packets to be transmitted onto a transmission buffer and when it is possible to transmit said plurality of data packets simultaneously, a unit that refers to packet sizes representative of data amounts of the respective data packets and to transmission rates of the respective data packets associated with receiver terminals, that checks packet time lengths of the respective data packets, and that selects said plurality of data packets whose packet time lengths are approximately equal to each other regardless of

their receiver terminals, the packet time lengths being transmission times defined by said packet sizes and transmission rates; and

a unit that commences the transmissions of said plurality of selected data packets simultaneously by use of a plurality of radio channels.

- 5 (11) A wireless packet communication apparatus that transmits data packets by MIMO by use of radio channels which are determined to be idle by carrier sense, between more than three STAs which can perform the MIMO on a plurality of signals for one radio channel, the wireless packet communication apparatus characterized by comprising:

a unit that individually manages, for each receiver terminal, a plurality of types of  
10 available transmission rates to be used for transmission of said data packets;

when there are a plurality of data packets to be transmitted onto a transmission buffer and when it is possible to transmit said plurality of data packets simultaneously, a unit that refers to packet sizes representative of data amounts of the respective data packets and to transmission rates of the respective data packets associated with receiver terminals, that  
15 checks packet time lengths of the respective data packets, and that selects said plurality of data packets whose packet time lengths are approximately equal to each other regardless of their receiver terminals, the packet time lengths being transmission times defined by said packet sizes and transmission rates;

a unit that determines, from the packet time lengths of said data packets and of  
20 acknowledgment packets to be calculated from the transmission rates of the data packets associated with destinations, time when the receiver terminals of the data packets transmit acknowledgment packets and stores, in the respective data packets, information on acknowledgment packet transmission time and information on a transmission deferral duration (NAV) which is a period of time taken for completion of the transmissions of  
25 acknowledgment packets to all of data packets transmitted simultaneously, the

acknowledgment packet transmission time being time when the receiver terminals of the respective data packets are allowed to transmit acknowledgment packets; and

a unit that simultaneously commences the transmissions of said plurality of selected data packets by the MIMO.

- 5 (12) The wireless packet communication apparatus according to claim 10 or 11, characterized by further comprising

a unit switching over to transmissions at lower transmission rates when a plurality of data packets whose packet time lengths are approximately equal to each other are selected in association with transmission rates lower than current transmission rates.

- 10 (13) The wireless packet communication apparatus according to claim 10 or 11, characterized by further comprising:

a unit that sets a first mode and a second mode, the first mode in which a plurality of data packets whose packet time lengths are equal to each other are generated by dividing a unit of data on a transmission buffer, the second mode in which a plurality of data packets  
15 whose packet time lengths are substantially equal to each other are generated by adding a dummy signal to at least one of said plurality of data packets whose packet time lengths are different from each other; and

a unit that compares transmission efficiency under said first mode to transmission efficiency under said second mode and selects, according to a result of the comparison, one  
20 of the modes to generate said plurality of data packets whose packet time lengths are approximately equal to each other.

- (14) The wireless packet communication apparatus according to claim 10, characterized in that a STA receiving said plurality of data packets including data packets addressed to an own station includes:

25 a unit that generates acknowledgment packets for the data packets addressed to the

own station and compares the receive rates of all the data packets received simultaneously;  
and

a unit that detects a maximum mandatory rate as a lowest receive rate and transmits  
said acknowledgment packets at said lowest receive rate, the maximum mandatory rate not  
5 exceeding a minimum value of said receive rates of all the data packets.

(15) The wireless packet communication apparatus according to claim 10, characterized  
in that a STA receiving said plurality of data packets including data packets addressed to an  
own station includes:

a unit that generates acknowledgment packets for the data packets addressed to the  
10 own station and compares the receive rates of all the data packets received simultaneously to  
each other; and

a unit that detects as a lowest receive rate a maximum mandatory rate not exceeding  
a minimum value of all the receive rates and detects as a local receive rate a maximum  
mandatory rate not exceeding the receive rate of the data packet addressed to the own  
15 station, when said receive rates of all the data packets are not equal to each other;

a unit that add a dummy bit to said acknowledgment packets to transmit them at  
said local receive rate when said local receive rate is higher than said lowest receive rate, the  
dummy bit corresponding to a difference between a first packet time length of an  
acknowledgment packet to be calculated from said lowest receive rate and a second packet  
20 time length of an acknowledgment packet to be calculated from said local receive rate; and

a unit that transmits said acknowledgment packets at said lowest receive rate when  
said local receive rate and said lowest receive rate are equal to each other.

(16) The wireless packet communication apparatus according to claim 10, characterized  
in that a STA receiving said plurality of data packets including data packets addressed to the  
25 own station includes:



a unit that generates acknowledgment packets for the data packets addressed to the own station and compares the transmission rates of all the data packets received simultaneously to each other;

5 a unit that detects as the lowest receive rate the maximum mandatory rate not exceeding the minimum value of all the receive rates and detects as a local receive rate the maximum mandatory rate not exceeding the receive rate of the data packet addressed to the own station, when said receive rates of all the data packets are not equal to each other,;

10 a unit that sets a transmission deferral duration (NAV) in said acknowledgment packets according to a packet time length of an acknowledgment packet to be calculated from said lowest receive rate and that transmits them at said local receive rate, when said local receive rate is higher than said lowest receive rate; and

a unit that transmits said acknowledgment packets at said lowest receive rate when said local receive rate and said lowest receive rate are equal to each other.

(17) The wireless packet communication apparatus according to claim 11, characterized  
15 in that a STA receiving said plurality of data packets including data packets addressed to an own station includes:

a unit that generates acknowledgment packets for the data packets addressed to the own station and detects acknowledgment-packet transmission times which are held in the data packets addressed to the own station; and

20 a unit that transmits said acknowledgment packets at the timing of the acknowledgment-packet transmission times at the maximum mandatory rate that does not exceed the receive rate of the data packet addressed to the own station.

(18) The wireless packet communication apparatus according to claim 11, by characterized by further comprising

25 a unit that detects a number (Nch) of idle radio channels and a number (Np) of data

packets whose packet time lengths are approximately equal to each other and transmits  $N_p$  data packets simultaneously by use of  $N_p$  idle radio channels without using the MIMO when  $N_{ch}$  is more than  $N_p$  ( $N_{ch} \geq N_p$ ), and that transmits a plurality of data packets simultaneously by use of the MIMO when  $N_{ch}$  is less than  $N_p$  ( $N_{ch} < N_p$ ).

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